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Investigating the Factors Affecting Information and Communication Technology (ICT) Usage of Turkish Students in PISA 2009

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Abstract

Information and Communication Technology (ICT) has become an indispensable part of the 21st century. Having basic ICT skills is now seen as an important attribute that members of the young cohort should possess in order to be successful in life. Thus, countries all over the world, including Turkey, have attempted to adjust their educational policies to this new phenomenon of ICT. In this context, this study aims to investigate the impact of both household- and school-level factors on the ICT usage of students in Turkey. Given the multilevel structure of the data, the hierarchical linear modeling (HLM) method was used for statistical analyses. The results of the analyses show that there are significant differences between schools in terms of students' ICT usage, both for entertainment and school-related tasks. These differences, however, are mostly explained by the household-level factors. The only school-related factor that seems to be important for students' ICT usage is the student's involvement in ICT-related tasks at school.

Keywords: ICT usage, HLM, Turkey, PISA

1. Introduction

Information technologies -more specifically, computers- entered our lives just a few decades ago. However, they have shortly become necessary components of our daily activities, from personal

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communications and entertainment to shopping and studying. It is getting harder every day to maintain our lives without having basic technological knowledge and skills in today's modern world. In addition, having basic computer competency has become an important prerequisite for finding a good job in almost every field (Felstead, Gallie, & Green, 2000), as many sectors have become dependent on computers and other technological devices. In general, it is safe to argue that basic Information and Communication Technology (ICT) skills in today's world have become comparable to traditional literacy. Thus, both individuals and countries have to understand the crucial role that ICT can play in their development and should not ignore its importance (Wilhelm, 2004).

In such a context, it is impossible for the educational systems of countries not to be affected by this new phenomenon of ICT. Indeed, building strong ICT competencies among the young cohort has started to be viewed as one of the most important educational objectives in many countries, especially in industrialized ones (Kuhlemeier & Hemker, 2007). Countries around the world have thus by developed national policies in order to integrate ICT into their education systems and have equipped their schools with computers and Internet connections along with other technological devices, beginning in the 1980s but especially after 1995 (Ham & Cha, 2009). As a result, educators have already begun to use technology in many different aspects of their profession, from curriculum development to classroom instruction (İşman, 2012).

Turkey is not an exception in terms of this recent global trend of ICT integration into education. During the last two decades, Turkish government has shown significant efforts to integrate ICT into the Turkish educational system. Similar to many other countries around the world (Kuiper, Volman, & Terwel, 2005), computer laboratories have been built and provided with Internet connections in schools all over the country (see Parlak-Yilmaz, 2011 for more comprehensive discussion about ICT integration process in Turkish educational system), especially after 2000. As a result of this effort, almost all Turkish schools now have computers with Internet for the use of students.

In addition to simply distributing computers to schools and connecting them to Internet, Turkey has also been demonstrating a current effort to increase the use of ICT for instructional purposes in schools. For example, the Turkish education system underwent important curriculum reform in 2005. One of the main objectives of this reform was the integration of ICT in instructions in Turkish schools (MEB, 2005). In addition, in 2010 the Turkish government announced a new project (FATIH) that aims to ensure the effective use of ICT in teaching and learning processes in all Turkish schools by equipping classrooms with computers, smart boards and high-speed internet and providing teachers with necessary in-service training. It is believed that the project will contribute to closing the achievement gaps among students from different backgrounds by ensuring their access with ICT (Alkan, et. al., 2011).

In spite of the significant efforts demonstrated so far, there still are considerable gaps between different sectors of societies in terms of their use of ICT, even in many OECD countries (Wilhelm, 2004). Likewise, previous studies in Turkey have also indicated great disparities among students who come from different socio-economic backgrounds (Gündüz & Hamedoğlu, 2003; Gündüz, 2010) and who live in different regions of the country (Güzeller & Akın, 2011) in terms of their access to and usage of ICT. In this context, it is important to find the factors that may impact students' use of ICT in their lives, either for entertainment or educational purposes, in order to take informed actions to minimize the inequalities among different groups. Thus, this research investigates the effects of different student-level and school-level variables on the ICT usage of students in Turkey by using a large-scale national data set (PISA-2009) collected by the Organisation for Economic Co-operation and Development (OECD).

By exploring the relative effects of different student-level and school-level variables on students' ICT usage in Turkey, this study attempts to find answers to the following questions: Which household characteristics significantly contribute to inequalities among Turkish students in terms of their usage of ICT? More importantly, can schools play a role for overcoming these inequalities? If so, which school characteristics should be targeted in this process?

2. Methodology

2.1. Data and Participants

This study uses the data from the 2009 cycle of the Programme for International Student Assessment (PISA). PISA is conducted by OECD in order to measure 15-year-old students' skills in three main school subjects—mathematics, science, and reading—in many OECD and non-OECD countries around the world. Since most of the participating students are getting toward the end of their compulsory education, PISA aims to explore these students' ability to use their knowledge and skills in real life and find out if they are ready to face the challenges of today's world. In addition to students' ability in the three main subjects, PISA also gathers information about students' families, homes, and school backgrounds as well as the students' interests and usage of ICT (OECD, 2012).

PISA was first conducted in 2000 in 43 countries and continued to be implemented every three years (2003, 2006, and 2009). Turkey has been participating in PISA since 2003. In the latest implementation (PISA-2009), which involved 65 countries (33 OECD and 32 partner countries) around the world, 4,996 students from 170 schools participated in Turkey. Among these students, 157 (3.1%) of them were in primary school, while 4,859 (97.3%) of them were high school students at the time of the implementation (MEB, 2010).

2.2. Variables

This study includes two dependent variables and several student-level and school-level independent variables. Models specified in the next section are analyzed separately for each dependent variable. PISA-2009 data is formed in two separate data sets; one based on student surveys and other based on school surveys. Dependent variables and the student-level independent variables used in this study are derived from the student data set, while school-level independent variables are derived from school data set. Below, each variable is described based on the PISA 2009 technical report produced by the OECD (Please see OECD, 2012 for more detailed information about these variables).

A) Dependent variables

ICT entertainment use (ENTUSE). In the data set, there is an index that represents the students' ICT use for entertainment purposes. The index was generated from eight survey items, which provide information on use of ICT and Internet for entertainment. Survey items used for generating this index can be seen in Table 1.

Table 1: Survey items for ICT entertainment use (ENTUSE)

Item	How often do you use a computer for the following activities at home?
IC04Q01	Play collaborative online games
IC04Q02	Use e-mail
IC04Q04	Chat online (e.g. MSN)
IC04Q05	Browse the Internet for fun (such as watching videos on YouTube)
IC04Q06	Download music, films, games, or software from the Internet
IC04Q07	Publish and maintain a personal website or blog
IC04Q08	Participate in online forums, virtual communities, or spaces (e.g. MySpace)
IC04Q09	Play collaborative online games

ICT use for school-related tasks (HOMSCH): The data set contains an index representing the students' ICT usage for school-related task. This index was compiled based on the five survey items, which can be seen in Table 2.

Table 2: Survey items for ICT use at home for school-related tasks (HOMSCH)

Item	How often do you do the following at home?
IC05Q01	Browse the Internet for schoolwork (e.g. preparing an essay or presentation)
IC05Q02	Use e-mail for communication with other students about schoolwork
IC05Q03	Use e-mail for communication with teachers and submission of homework or other schoolwork
IC05Q04	Download, upload, or browse material from your school's website (e.g. time table or course materials)
IC05Q05	Check the school's website for announcements, e.g. absence of teachers

B) Independent variables

Student-level variables

ICT availability at home (ICTHOME): This variable corresponds to the availability of eight items (desktop computers, laptops or notebooks, Internet connection, video game console, mp3/mp4 player, cell phone, printer, USB [memory] stick) at home.

Highest occupational status of parents (HISEI): Information about the occupation of students' parents was collected by open-ended questions. Then, students' responses were translated into the international socio-economic index of occupational status (ISEI). This variable is the higher ISEI score of either parent or the only available parent's ISEI score.

Highest parental education (PARED): This variable corresponds to the highest years of schooling attained by either parent or the only available parent's years of schooling.

Family wealth (WEALTH), Cultural possessions (CULTPOS), Home educational resources (HEDRES): These three indices were calculated based on students' responses to the availability of different household items at home.

ICT availability at School (ICTSCH): This variable is computed based on the availability of five items (desktop computers, laptops or notebooks, Internet connection, printer, and USB (memory) stick) to students at school.

Use of ICT at School (USESCH): This variable corresponds to the student's involvement in ICT-related tasks at school

School-level variables

School size (SCHLSIZE): This variable indicates the total number of students at school based on the enrolment data provided by the school principal.

The student-teacher ratio (STRATIO): This variable is the ratio of total numbers of teachers (the number of part-time teachers is multiplied by 0.5) to the school size.

Availability of computers (RATIOCOMP): This variable corresponds to the ratio of computers available to 15-year-olds to the total number of students in this age group.

Availability of Internet (COMPWEB): This variable represents the ratio of computers connected to the Web to the total number of computers available to 15-year-olds.

Extra-curricular activities (EXCURACT): This variable is computed based on the school principals' answers to question of what extra-curricular activities occur at their school.

Quality of educational resources at school (SCMATEDU): This variable is computed based on the school principal's responses to questions about potential factors hindering instruction at school.

2.3. Empirical Strategy

Hierarchical linear modeling (HLM) method is used in this study to investigate the effects of student-level and school-level variables on students' usage of ICT in Turkey because of the multilevel nature of the data. HLM is known as an appropriate method to use when individuals are nested in groups (e.g. students are nested in schools, as in this study) because it takes within-group variations into account and allows intercepts and slopes to vary by group (Raudenbush & Bryk, 2002). HLM 6.08, a statistical software that is specifically designed for the application of HLM analyses, is used in this study (Raudenbush, Bryk, & Congdon, 2004). PISA-2009 data are weighted and includes weighted variables at both student and school levels. Therefore, sample weightings were applied to the data before conducting statistical analyses to ensure representative estimates.

In the HLM framework, a one-way ANOVA model that does not include any covariate, is estimated first in order to investigate how much variation in students' ICT usage occurs within and between schools. Based on the information derived from the results of the one-way ANOVA analysis, intra-class correlation (ICC), which is the proportion of level-2 variance to the total variance, is calculated (Raudenbush & Bryk, 2002).

One-Way ANOVA model:

$$\text{Level-1: } Y = \beta_{0j} + r_{ij} \text{ (Students)}$$
$$\text{Level-2: } \beta_{0j} = \gamma_{00} + u_{0j} \text{ (Schools)}$$

Second, a multilevel model, which includes both student- and school-level variables, is estimated in order to investigate the effects of these variables on students' ICT usage.

Final model:

At Level-1, for student i in school j,

$$Y_{ij} = \beta_{0j} + \beta_{1j}\text{ICTHOME} + \beta_{2j}\text{HISEI} + \beta_{3j}\text{PARED} + \beta_{4j}\text{WEALTH} + \beta_{5j}\text{CULTPOS} + \beta_{6j}\text{HEDRES} + \beta_{7i}\text{ICTSCH} + \beta_{8i}\text{USESCH} + r_{ij}$$

In this model, β_{0j} is an intercept for school j and r_{ij} is random error, while $\beta_{1j}, \beta_{2j} \ldots \beta_{8j}$ are coefficients for each student-level variable, which vary across schools.

At level-2,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\text{SCHLSIZE} + \gamma_{02}\text{STRATIO} + \gamma_{03}\text{RATIOCOMP} + \gamma_{04}\text{COMPWEB} + \gamma_{05}\text{EXCURACT} + \gamma_{06}\text{SCMATEDU} + u_{0j}$$

While γ_{00} is a constant that represents the grand mean and u_{0j} is a random effect that captures the variations in school level, $\gamma_{01}, \gamma_{02} \ldots \gamma_{06}$ are the coefficients associated with each school-level variable.

3. Findings

In this section, results of HLM analyses are presented. Analyses of the above specified models were estimated for both dependent variables, ICT entertainment use (ENTUSE) and ICT use at home for school-related tasks (HOMSCH), in order to see the factors significantly affecting the students' usage of ICT for entertainment purposes and for school-related tasks in Turkey.

3.1. Results of One-Way ANOVA Analyses

According to one-way ANOVA analyses, variance components at level-2 were significant ($p \leq 0.001$) for both dependent variables (ENTUSE and HOMSCH), indicating significant variations between schools in terms of students' ICT usage. Thus, intra-class correlations (ICCs) were calculated in order to find out how much variance lies between schools. ICC for ENTUSE was calculated as 0.18 (0.37/1.71+0.37), while ICC for HOMSCH was 0.13 (0.18/1.25+0.18). These results mean that 18% of the total variance in ENTUSE and 13% of the total variance in HOMSCH lies between schools.

Based on these results, it can be argued that there are important differences between Turkish schools in terms of students' ICT usage both for entertainment and school-related tasks, especially for entertainment use. Given the significant achievement differences found between Turkish schools based on PISA results (Delen & Bulut, 2012; Demir, Dündar, & Akın, 2010), this finding is not surprising. Since significant differences are found between schools, the next step should be determining the factors contributing to these differences. Therefore, a two-level HLM model, which includes both student-level and school-level variables, is analyzed.

3.2. Results of Final HLM Model

After finding significant variations between schools in terms of students' ICT usage, a final HLM model was employed separately for both dependent variables. Results of these analyses are reported in Table 3. According to the results, it can be argued that student-level variables have a stronger association with students' ICT usage, either for entertainment or school-related tasks, compared to school-level variables. For example, ICT availability at home (ICTHOME) and home educational resources (HEDRES) are significantly ($p \leq 0.01$) associated with ICT usage for both entertainment and school-related tasks. While family wealth is only significant ($p \leq 0.05$) for ICT usage for entertainment purposes, parents' occupations, parental education, and cultural possessions at home were not found to be significant determinants of students' ICT usage.

In terms of the school-level variables, there is only one variable—school size—that has a statistically significant ($p \leq 0.01$) association with students' ICT usage (only for school-related tasks). However, there are also two student-level variables that are related to ICT availability in school specifically for an individual student. These variables are the availability of different ICT items (e.g. desktop computers, Internet connection, etc.) to the student at school (ICTSCH) and the student's involvement in ICT-related tasks at school (USESCH). Between these two variables, the latter is also significantly ($p \leq 0.01$) associated with students' ICT usage both for entertainment and school-related tasks. School-level

variables, such as the availability of computers at school, availability of Internet at school, quality of educational resources at school, etc., were not found to be important determinants of students' ICT usage in Turkey.

Table 3: A summary of fixed effect estimations for final HLM model

Variables	Coefficient (E)	Standard Error (E)	Coefficient (S)	Standard Error (S)
INTERCEPT	0.138	0.226	0.511**	0.199
School-level variables				
SCHLSIZE	- 0.000009	0.00013	0.0002**	0.00007
STRATIO	0.003	0.005	0.005	0.005
RATIOCOMP	- 0.253	0.264	0.056	0.095
COMPWEB	0.000006	0.00002	0.00002	0.00003
EXCURACT	- 0.007	0.043	- 0.025	0.059
SCMATEDU	0.044	0.058	0.008	0.014
Student-level variables				
ICTHOME	0.527**	0.040	0.[illegible]5**	0.045
HISEI	0.0008	0.002	- 0.000	0.002
PARED	0.014	0.011	- 0.0006	0.007
WEALTH	0.088*	0.04	- 0.005	0.044
CULTPOS	0.031	0.0	036	0.027
HEDRES	0.089**	0.03	119**	0.027
ICTSCH	0.044	0.027	0.025	0.021
USESCH	0.228 **	0.031	0.343**	0.030

* p≤ 0.05, ** p≤ 0.01, E: ENTUSE, S: HOMSCH

4. Conclusion

This study aims to explore the effects of student- and school-level factors on students' ICT usage for either entertainment or school-related tasks in Turkey. Data from PISA 2009 is analyzed by using hierarchical linear modeling (HLM) because of the multilevel nature of the data. Although the results of the study show that there are significant differences between schools in terms of students' use of ICT both for entertainment and school-related tasks, school-level variables were not found to be significant predictors of ICT usage for either dependent variables with the exception school size for school-related tasks. However, one of the student-level variables—the student's involvement in ICT-related tasks at school, which is related to school—was found to be a strong predictor of students' ICT usage both for entertainment purposes and school-related tasks.

Results of the study imply that although factors corresponding to students' households, such as ICT availability at home and household educational resources, significantly influence students' ICT usage, teachers and administrators can also increase students' ICT usage by creating opportunities for students to be involved in ICT-related tasks in school. However, it seems that simply increasing the number of computers or other ICT devices in schools does not contribute to the students' usage of ICT. Therefore, school administrators and teachers should be encouraged to more effectively use ICT devices in their schools and increase students' engagement in ICT-related activities. Further research may also be conducted to find which specific ICT-related activities may contribute most to students' ICT usage and the role of teachers and school administrators in promoting these activities for students.

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